Summary

Increasing food security and reduction of risk is a recurring theme in the agricultural development programmes of the 1990s. Shortage of water is the most serious physical constraint on production in semi-arid areas. The work described in this document is based on the premise that supplementary water can be used more efficiently if applied at the beginning rather than at the end of the season. It is suggested that raising some proportion of sorghum and millet crops in nurseries using small amounts of water and transplanting seedlings could be a way of extending the growing season in short duration rainfall areas, thus providing an extra dimension to food security.

Plate 1. Transplanted sorghum in a farmer's field Mashate, Masvingo Province, Zimbabwe, 1999

CONTENTS

INTRODUCTION

The problem:

Increasing food security and reduction of risk is a recurring theme in the agricultural development programmes of the 1990s. Sorghum (the world's fifth most important cereal) and pearl millet, although less widely grown is a crop with a strong poverty focus, are grown mainly in the semi-arid and arid tropics and sub-tropics and together form a major food source in Africa. Maize is usually grown in wetter areas, although its popularity is such that, even in zones where success is not guaranteed, farmers continue to plant the crop, often against extension advice. Shortage of water is the most serious constraint on production. In consequence, programmes have been initiated to conserve water for supplementary irrigation during the growing season. However, this proposal is based on the premise that small amounts of water can be used most efficiently at the beginning of the season, to 'extend' the effective growing season.

Current practices:

Transplanting cereal seedlings from irrigated nurseries has been adopted in several areas as a means of improving food security by extending the growing season in areas with patchy and unreliable rainfall, or where the rainfall may not support a second crop. In most rice growing countries, the use of cereal nurseries is commonplace. Linked to accurate sowing rates and input application the process guarantees reasonable crops by reducing risk and affording best use of water.

In Vietnam, the National Maize Research Institute has developed a low-cost maize production system on the Red River Delta based on transplanting maize into soils previously used exclusively for rice (Tran Hong Uy 1996[1]; Ngo Huu Tinh *et al.* 1992[2]).

In Africa on the shores of Lake Chad in Borno State, NE Nigeria, nursery sorghum beds are sown and nurtured at the edge of the lake. When the time is right the seedlings are planted on the lake bed as the water recedes from the lake, an older stand is established very quickly, allowing the crop to mature with the water that is available (Olabanji *et al.* 1996[3]). This activity includes all members of the family, men women and children and the sorghum plantations extend as far as the eye can see.

Similar scenarios can be witnessed in the foothills of the Atakora chain near Natitingou, Benin where the Somba tribe cultivate transplanted millet and in the Nampula region of Mozambique where sorghum is transplanted in opportunistic attempts to increase area under cultivation when the rains are good. A similar practice has been observed in Save Valley, Zimbabwe

[1] Tran Hong Uy (1996) Transplanting maize on wetland. A technical manual based on a successful case-study in Vietnam, FAO 1996

[2] Ngo Huu Tinh *et al.* (1992) Winter Maize in the Red River Delta of Northern Vietnam: Problems and Prospects.

[3] Olabanji *et al.* (1996) Production and Management. Survey of masakwa sorghum growing in Northeastern Nigeria, ISMN 37 61-63

Conversely, in Zimbabwe and other semi-arid areas, near-subsistence farmers often have to broadcast their sorghum seeds several times, as time and again, the wind and sun scorch and desiccate the germinating seedlings when the rains fail (R6395[4]).

In general, indigenous, but largely unquantified information suggests that where transplanting is practised a better stand is established, more yield may be obtained per hectare and a greater degree of food security experienced by the people.

The solution:

That similar methods have evolved in diverse regions suggests that the practices may have application elsewhere. It is suggested in this project that raising maize, sorghum or millet in nurseries using small amounts of water and transplanting seedlings could be a way of extending the growing season in short duration rainfall areas. This practice could provide an extra dimension to food security. Seedlings may either be irrigated with minimal amounts of water until the rains become fully established or may be grown on residual moisture already collected previously in micro-dams or similar water conservation structures.

THE EXPERIMENTAL WORK

The Pilot Project

The Centre for Arid Zone Studies funded a pilot study with the aid of a generous donation from the famous Kenyan born musician and ex-Bangor student Mr Roger Whittaker via the University of Wales Bangor Development Trust Fund. Mr Michael Parry Griffiths spent a year working at the Save Valley Research Station, Zimbabwe and with the Rural Unity For Development Organisation (RUDO) an Oxfam-affiliated NGO in Masvingo. The work tested the idea that it is possible to grow sorghum in nurseries using small amounts of water and then transplant the seedlings when it starts to rain.

This initial work with sorghum at the Save Valley Experimental Station in Zimbabwe demonstrated that the idea was worth pursuing. The initial experiments focused on nurseries of different plant densities and different planting out times. In the graphs below (Figures 1 & 2) the coloured bars in the first group of data ('sown') in Figure 1 refer to plants which were direct sown on the same day as plants which were transplanted from the 20 (red), 30 (green) and 40 (blue) day old nurseries. The second group of data ('transplanted') shows the mean number of days to 50% flowering of plants transplanted from 20 (red), 30 (green) and 40 (blue) day old nurseries.

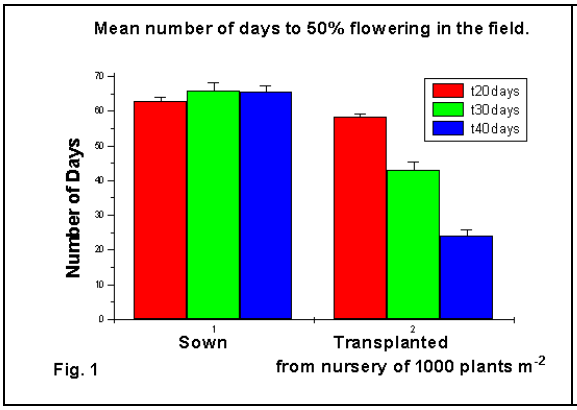

Fig. 1

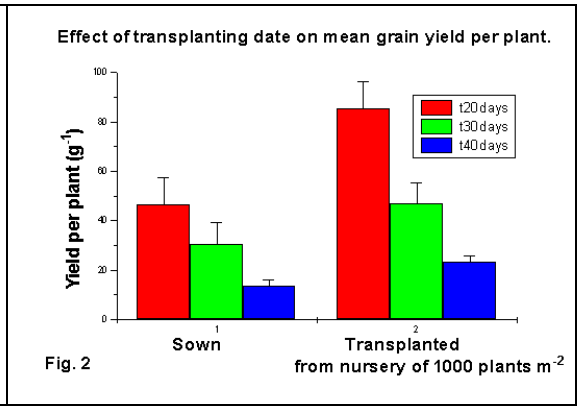

Fig. 2

[4] DFID funded project R6395 "The development and testing of seed priming to improve stand establishment, early growth and yield of crops in semi-arid Zimbabwe and India

The plants from 20 day old nurseries flowered slightly earlier than the plants direct sown on the same day. The older the plants when they are transplanted the earlier they flower in the field compared to plants direct sown at the same time. Plants from 40 day old nurseries took only 20 days to reach 50% flowering whilst the plants direct sown on the same day did not flower for more than 60 days. This could be useful for farmers who have access to a water supply (e.g. micro-dams or wells) in areas of very short duration rainfall.

In this pilot project there was a yield advantage (Figure 2) for the plants which had been transplanted from a 20 day old nursery over those direct sown on the same day (red bars). The difference is less marked with plants from the older nurseries (green and blue bars). Although a yield advantage is shown here for the transplanted plants, we stress that this is data from one year only and that these experiments are being repeated. However, this result is encouraging as it suggests that it is unlikely that there will be any significant yield penalties due to transplanting compared with direct sown crops. It should also be noted that the rainfall was above average in Zimbabwe in the 1998/99 season and that had the rain not continued into the season, the benefit from the transplanted plants could have been greater.

Farmer participation

We also worked with a group of farmers who spontaneously created their own nurseries and transplanted sorghum in their own way.

A group of 6-8 farmers planted a nursery on Mr Madzokere's farm in Mashate Masvingo Province. His homestead was selected by the farmers as he has a well on his property.

The seeds were sown in a nursery and the farmers shared the seedlings and helped each other with the transplanting, when the seedlings were one month old. They observed that Mr Madzokere's crop was the best because he did not have to transport his seedlings very far. They thought the technique had potential and wanted to be included in any further trials.

People came from far and wide to admire this farmer's crop and it was described by villagers as "headturningly good".

Plate 2. Mr Madzokere in his transplanted sorghum field

Conclusion

The pilot study has shown that transplanted plants flower earlier in the field than those sown at the same time (Fig. 1) and that transplanted plants in this pilot study out-yield plants sown at the same time (Fig. 2). Nurseries of 1000 plants m^{-2} were found to be optimal. It was concluded that sorghum can be transplanted without reducing yield in a good/normal season and that a nursery of 5m x 6m will provide enough plants for 1 ha of sorghum in SE Zimbabwe conditions. On this basis, further funding was sought for expansion of the work.

The Current Project

Department of International Development (DFID) funding has enabled us to develop the pilot project into a three year project (R7341). A Bangor based Research Assistant, Ms Andrea Mottram and two University of Zimbabwe Students Steven Mapfuto and Sandra Kadungure are working on the project.

Project purpose

Minimising the risk of failed crops, patchy stands and costs of re-planting and increasing food security *i.e.* some improvement during years when the rain is late; and a "safety net" of plants provided when the rains are erratic.

The project has been divided into three phases:

Phase 1
Characterisation of the physical and socio-economic constraints to the adoption of transplanting, and other non-standard techniques for improving crop establishment as a means of increasing food security.

Phase 2
Analysis of the suitability of locally available varieties and landraces to transplanting. This includes controlled environment experiments at Bangor as well as on-station and participatory on-farm studies in Zimbabwe

Phase 3
Identification of areas for the application of transplanting techniques, and development of optimal methodological strategies with men and women farmers.

(For more information see the project Logical Framework attached - Appendix 1)

Project Activities

On-station research at the Save Valley Experiment Station

The trials conducted in the 1999/2000 season compared transplanting at various ages of two pearl millet varieties; PMV2 and PMV3, and two sorghum varieties; Marcia and Muchayeni.

In September approximately 2 months before the expected rainfall 1m x 1m bunded nurseries were constructed ready for nursery establishment. Four replicate nurseries per variety were sown every 10 days to provide approximately 20, 30 and 40 day old seedlings to be ready at the onset of rain. 2000 seeds were sown in each nursery to allow for a $1000m^2$ density after thinning. Nurseries were watered twice daily due to very high temperatures.

After rainfall at the beginning of November, 26, 36 and 46 day old seedlings were transplanted into 5m x 5m plots at a density or 75 plants per plot. At the same time other plots were direct sown with dry seed and seed primed in water for 12hours, as a comparison to the transplanting.

A small maize trial was also conducted using variety R201. Direct sown dry and primed seed, and 38 day old transplanted seedlings were compared.

Trials were conducted concurrently by Mr Steven Mapfumo, a University of Zimbabwe student studying for a M.Phil. degree. Using the same format as above he compared the growth differences between transplanted plants which had their leaves cut leaves and those with leaves left intact. This experiment was based on observations that farmers in the Lake Chad area of Nigeria trim leaves and roots of their plants prior to transplanting, and that farmers who gap-fill also trim leaves to reduce transpiration.

Participatory on-farm work

Farmers were impressed with the results of the first on-farm transplanting exercise conducted in the Pilot Project and the work has been expanded to three settlements in Masvingo and to villages close to the Save Experiment Station.

Initial meetings were held to introduce the concept of transplanting and to asses the level of interest. After a large expression of interest further meetings were held to explain the details of the trials and identify the participants. The number of farmers involved for the initial trials was limited to 25 (10 in Chendebvu 5 in Nemavuzhe and 10 in Mashate) for logistic reasons and a pre-requisite for participation was access to water outside the rain season. Farmers themselves then chose who would conduct the trials.

Each farmer received 2kg of Marcia sorghum seed on the understanding that 4kg would be returned to the project at harvest. Farmers established 2 nurseries approximately 10 days apart, 1/2 kg for each. They were given guidelines as to the nursery set-up but the exact construction and management was left to the individual farmer.

The time of transplanting was at the farmers discretion although it was suggested that it should follow a period of rainfall. As a control the farmers were asked to direct-sow 1kg of seed following their normal practices. Farmers were asked to record sowing dates and amounts of water added to the nurseries.

Early indications from this year's trials reveal that farmers consider their transplanted sorghum to be doing better than sorghum grown as usual. Comparisons will be made between the on-station trials and the on-farm trials to determine yield advantage if any. Social implications of transplanting are also being considered, with particular emphasis on gender responsibility and priorities.

UK-based work

The UK work is being conducted at the Centre for Arid Zone Studies (CAZS). CAZS is also responsible for the overall co-ordination of the project both in the UK and Zimbabwe.

All experimental work is carried out at the University of Wales, Bangor using controlled environment cabinets and greenhouse facilities based at Pen-Y-Ffridd

Experimental Station, and laboratories. This part of the work has only recently commenced (March 2000) and will be reported at a later date.

IMPRESSIONS FROM THE FIELD

Plate 3
Introductory meeting with farmers in Chendebvu.

We have a total of 25 RUDO farmers from three villages participating in the project. The farmers were given seed and asked to follow their existing practices for direct sown seeds and to transplant from their nurseries into land adjacent to their "control" crop.

Plate 4
No two nurseries were the same, with farmers using their own initiative and ideas to fit their own requirements. Ideas and experiences will be shared in a Post Harvest workshop in May 2000

Nurseries are fenced to prevent animals from straying into them

Plate 5

Nurseries with two different planting dates. The left nursery is 14 days younger than the nursery on the right

Plate 6

Farmers were asked to record the amount of water used and the frequency of application.

Not many people have watering cans. This is a home made watering 'sieve' created by punching holes in the bottom of an enamel pot.

Plate 7

Mr Zezais is a "Master Farmer" a community award for being an innovative farmer and a source of ideas and inspiration for others.

Mr Zezais is one of the few men involved in the transplanting project.

Plate 8

Both plates 7 & 8 show a clear difference between transplanted sorghum and direct sown sorghum. The transplanted sorghum is to the right of each picture.

Plate 9

The transplanted sorghum in the background is clearly better established and more advanced than the direct sown crop in the foreground

Plate 10 (cover photograph)
Mrs Maunganidze was one of the farmers who had harvested her sorghum before the cyclone hit Zimbabwe in February. This was a clear benefit of transplanting for her.

CONCLUSION

It appears that transplanting is a technique that can be used by farmers to produce an earlier crop under Zimbabwean conditions. In Zimbabwe there is a 'lean' period towards the end of the year when the stores from the previous year's harvest have been used. Being able to produce grain for this period would provide food, but also a source of income when prices are high.

The work reported is in its initial stages. The first season data is being analysed and further investigations, both agronomic and socio-economic are being conducted on-station, on-farms and in the UK.

Unfortunately Zimbabwe was badly affected by a cyclone which hit southern Africa in February. Some farmers have lost all their crops, but others e.g. Mrs Maunganidze (see Plates 9 & 10) had harvested her transplanted sorghum before the onset of the inclement weather. It is not clear yet how our final yield data has been affected.

Acknowledgements

The Pilot Project was generously funded by the musician Mr Roger Wittaker via the University of Wales, Bangor Development Trust Fund. We thank him and all our collaborators and the participating farmers.

The current work is being funded by the UK Department For International Development's Flexibility Fund (Project R7341) and is for the benefit of developing countries. The views expressed are not necessarily those of DFID and DFID can accept no responsibility for any information provided or views expressed.